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Assessing the Potential for a FEMP Operations and Maintenance (O&M) Program to Improve Energy Efficiency

W.D. Hunt
G.P. Sullivan

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Prepared for the
U.S. Department of Energy
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Federal Energy Management Program
under Contract DE-AC06-76RL01830

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Richland, Washington 99352

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SUMMARY

Executive Order 13123 mandates that Federal agencies reduce energy use by 35% relative to 1985 energy use by the year 2010. To satisfy this mandate, Federal agencies will need to utilize many different energy management approaches. One approach that to date has not been fully explored is that of improved operations and maintenance (O&M). The U.S. Department of Energy's (DOE's) Federal Energy Management Program (FEMP) is developing program offerings in support of improved Federal O&M activities to further the ability of agencies to meet the 2010 energy reduction goal. This assessment was completed to determine the potential benefits of an expanded FEMP O&M program offering, while also taking into account the expressed O&M needs of the Federal agencies. The main conclusions of this assessment are summarized as follows:

- The potential energy savings available to the Federal facilities sector through improved O&M practices is conservatively estimated to be 10%. If achieved, these energy savings can contribute significantly to the effort aimed at meeting the mandated 2010 energy reduction goal of 35%. This also represents an annual potential energy cost savings of $301 million based on the 1985 baseline.

- There are additional significant operational benefits available to Federal sites that improve O&M practices including:

    - extended equipment life – reducing future capital funding requirements

    - healthier, safer, and more productive work environments

    - improved building occupant comfort - reducing occupant trouble calls/complaints.

- The agency feedback/input process used in this assessment identified the following needs for O&M program offerings:

    - Model O&M incentive contract language and the ability to effectively administer contracts because well over 50% of the Federal floor space O&M is now outsourced, and this amount is expected to grow in the coming years.

    - Guidance on an array of O&M issues, strategies, and practices (i.e., commissioning, metering, controls design and operation, etc.)

    - Additional FEMP O&M training course offerings including specialized training (i.e., boiler and chiller operations, maintenance of control systems, site auditing, etc.).

- Recommendations for the FEMP O&M program offerings through FY04 are as follows:

    - Begin activities aimed at the key areas of needs and opportunities: develop model language and performance incentives for O&M outsourcing, provide technical assistance to agencies in applying new O&M-based technologies and strategies, provide technical assistance in the area of metering and sub-metering, and develop technical guidance on a range of energy-efficiency-related O&M issues such as O&M contract management, building and equipment commissioning, building and equipment metering, and incorporating O&M requirements into new building designs.

    - Build O&M program visibility in FY03 through focused outreach and communication activities.

    - Develop a long-range O&M program plan that targets a 3- to 5-year implementation window.

ABBREVIATIONS AND ACRONYMS

BOC	Building Operator Certification
CHP	central heating plant
DDC	direct digital control
DOE	U.S. Department of Energy
DSOM	Decision Support for Operations and Maintenance
EMCS	energy management and control system
ESPC	energy savings performance contract
FEMP	Federal Energy Management Program
FFC	Federal Facility Council
FY	fiscal year
GAO	Government Accounting Office
GSA	General Services Administration
HUD	Housing and Urban Development
HVAC	heating, ventilation and air conditioning
IEQ	indoor environmental quality
IFMA	International Facility Management Association
LBNL	Lawrence Berkeley National Laboratory
O&M	operations and maintenance
PNNL	Pacific Northwest National Laboratory
R&A	repair and alteration
USPS	United States Postal Service

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1.0 INTRODUCTION

This section provides a general discussion covering the objectives of this assessment, the opportunities presented by improving O&M, and the benefits of O&M in improving energy efficiency.

1.1 Overall Objective

Effective O&M is one of the most cost-effective methods for ensuring reliability, safety, and energy efficiency. Inadequate maintenance of energy-using systems is a major cause of energy waste in both the Federal government and the private sector. Energy losses from steam, water and air leaks; uninsulated (steam, hot water, and chilled water) lines; maladjusted or inoperable controls; and losses from poor maintenance are often considerable. Good maintenance practices can generate substantial energy savings and should be considered a resource. Moreover, improvements to facility maintenance programs can often be accomplished immediately and at a relatively low cost.

FEMP is interested in capturing this resource by institutionalizing proactive O&M at Federal facilities because properly operated and maintained building systems use less energy and, thus, would play an integral part in providing agencies with more alternatives to meet the mandated Federal energy reduction goals. However, to make a solid business case, FEMP must also demonstrate to Federal agencies the overall benefits of O&M in a way that clearly articulates the advantages beyond improved energy efficiency.

The objective of this assessment of a FEMP-based O&M program is to identify the potential opportunities and benefits available to FEMP and its clients through program-driven improvements in Federal O&M practices. This assessment will:

- estimate the potential energy and cost savings available through improved O&M practices
- identify the most significant (energy-related) O&M concerns of Federal agencies
- develop recommendations for short- and long-term FEMP O&M program actions based on feedback from agency O&M officials.

1.2 The Opportunity

There is a significant opportunity available through proactive O&M and implementation of O&M strategies. These opportunities are specifically discussed in the following sections.

1.2.1 Benefits and Savings

We hear and use the term "O&M" quite frequently in the context of facilities management and even energy efficiency. For the purposes of this assessment, the term O&M refers to decisions and actions regarding the control and upkeep of property and/or equipment. (See Appendix A for definitions of O&M terms.) The need for effective building O&M is illustrated in Figure 1, which shows how, over time, the performance of a building (and its components) will eventually degrade and that the service life of the building is prolonged through effective O&M. Not shown in this figure is the additional benefit of reduced building (energy) operating costs resulting from effectively maintaining mechanical and electrical equipment [e.g., lighting; heating, ventilation, and air conditioning (HVAC); controls; and on-site generation].

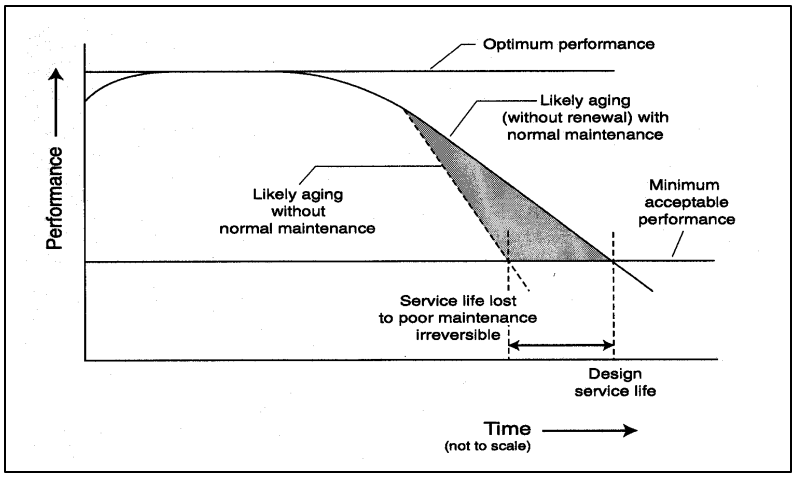

FIGURE 1. Effect of Adequate and Timely Maintenance and Repairs on the Service Life of a Building (National Research Council 1998) Reprinted with permission from "The Fourth Dimension in Building: Strategies for Minimizing Obsolescence". Copyright 1993 by the National Academy of Sciences. Courtesy of the National Academy Press, Washington, D.C.

The estimated level of energy savings available through improved O&M practices is difficult to quantify because there is a wide range of estimates of the potential savings from reaching the optimal efficiency point. **For the purposes of this assessment, our estimate of 10% achievable energy savings will be used (see Sections 2.1 and 2.2). The estimated annual Federal dollar savings resulting from this level of O&M improvement is $301 million.**

In addition to energy savings associated with proactive O&M programs, other benefits should be realized, many of which may be viewed as more important to building operators and tenants:

- equipment operates more reliably
- safer equipment operations

- increased occupant comfort
- extended equipment life.

1.2.2 Federal Agency O&M Needs

Identifying the potential for energy and cost savings in Federal facilities is a significant, but not the only, consideration for determining the overall potential for a FEMP O&M program. A successful FEMP O&M program must also identify and respond to the needs of the target audience – the Federal agencies. To assess these needs, FEMP and PNNL staff talked with agency O&M staff to determine the following:

- the agencies' most significant O&M issues
- the organizational relationship between the O&M and energy-efficiency programs at the agencies and sites
- how O&M and energy programs interact, and on what issues
- what percentage of the agency or site square footage has outsourced O&M
- what FEMP can do to help agencies improve their O&M practices.

The primary findings of this agency feedback process are as follows:

- Outsourcing of O&M creates a need to be able to ensure proper work is completed, and completed correctly.
- Agencies want increased resources to allow for improvement in site O&M delivery inclusive of increased and more specialized training.
- Agencies want technical guidance on a range of O&M topics such as maintaining control systems and primers on technologies and strategies.

Section 3 contains a summary of the agency data gathering process and a more detailed presentation of the key findings. The potential activities presented in Section 4 take into account the agency feedback and attempt to address recognized agency O&M needs.

1.3 Connecting O&M and Energy Efficiency

According to Federal facility managers, the primary objective of O&M programs is to ensure the continuity of services in support of the buildings' tenant and/or mission needs. This includes preserving the value of the assets and providing a safe and environmentally desirable workspace. The range of building services includes energy intensive equipment such as lighting and thermal comfort systems (HVAC); as well as painting, general carpentry, elevators and escalators (which are energy intensive); general plumbing; general electrical; and utility plant operation. In their daily operations, site-level O&M

managers must prioritize their activities based on a number of factors such as overall mission importance and availability of resources (staffing and funding). In fact, factors such as number of customer complaints, size of work backlog, inventory levels, and amount of unscheduled to scheduled work performed are often measures of the effectiveness of a site's O&M program. The reality is that energy efficiency is usually a secondary or tertiary objective for Federal O&M managers because it represents a small subset of the overall O&M requirements.

This wide range of services administered through site O&M organizations demonstrates the need for FEMP to clearly understand site-level O&M activities. Specifically, what are the actual site-level O&M capabilities and priorities? What do the sites/agencies want from FEMP that can help them improve their ability to provide O&M services AND save energy? As part of the development of this assessment, this understanding was developed through direct contacts with agency and site O&M staff . This was seen as a critical step in obtaining agency buy-in for the new FEMP O&M program and its services. As noted above, FEMP has met with Federal agency staff to develop a better understanding of capabilities, priorities, needs, and ways in which FEMP can help satisfy those needs. Under this arrangement, the "traditional" FEMP/agency relationship of working primarily with the agency energy management coordinator has been at least temporarily set aside to build these new relationships with Federal O&M staff and managers.

2.0 BENEFITS FROM IMPROVED O&M

The many benefits from an improved O&M program are discussed in the sections below.

2.1 O&M Savings Potential

Estimating the Federal potential energy and dollar savings resulting from improved O&M is difficult. Many variables weigh into the equation including the variety of equipment, its age, and condition; O&M program characteristics; general staff capabilities; available diagnostic equipment; etc. In addition, our research indicates that there is very little data specific to the Federal sector that quantifies short- or long-term O&M performance. These barriers aside, this analysis will make use of reasonable assumptions and applicable private-sector studies (notably, a variety of studies of O&M practices as they apply to the commissioning of existing buildings) to estimate the potential.

The overall potential for O&M savings can be expressed in the following categories.

Energy Savings. O&M related energy savings result from optimizing operations and maintaining equipment at the optimal point of efficiency – the point of operational efficiency. Activities affecting these savings usually involve requiring that equipment is operated, controlled, and maintained per the intended design and/or manufacturer's specifications. While there is a wide range of estimates of the potential savings from reaching operational efficiency, most studies put the range between a low of 5% (Thompson 1986) and a high of 30% (Piette 1992). For the purposes of this assessment, we have decided that a conservative assumption is appropriate; therefore, we have settled on a 10% achievable energy saving potential.

Equipment Life Extension. Equipment manufacturers and operators attest to poorly maintained equipment breaking down more often, and needing to be replaced sooner than well-maintained equipment. This point is illustrated by the Building Owner and Managers Association (BOMA 1996) using an example of a 20-ton reciprocating roof-top air conditioner. This unit has a manufacturer's expected life of 14 years. Figure 2 presents these data, where Curve 1 represents minimal maintenance (e.g., only corrective maintenance is performed to keep equipment running), and Curve 2 represents comprehensive and recommended maintenance. BOMA characterizes the O&M activities on Curve 1 as poor preventive maintenance, including rarely changing filters/belts, and greasing bearings only when critical need is reached or failure occurs. Curve 2 represents scheduled and preventive maintenance at regular intervals to maintain equipment operation and efficiency.

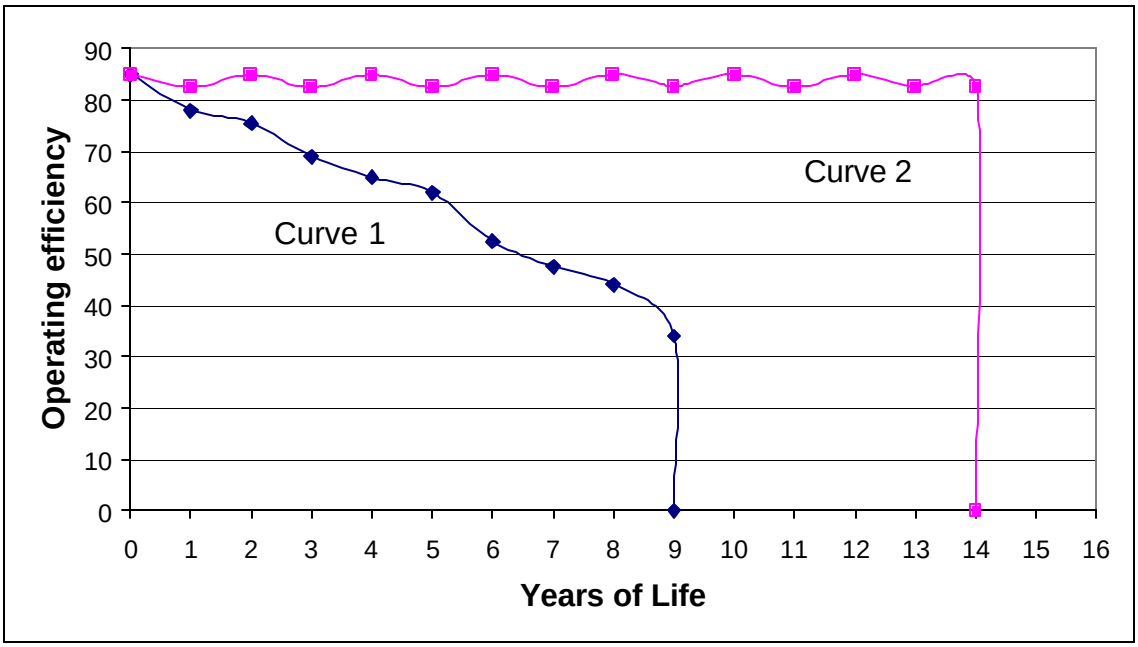

FIGURE 2. BOMA Equipment Degradation Curves

From BOMA's data, the poorly maintained unit (Curve 1) resulted in a 9-year life with degrading efficiency (rising energy use and cost) throughout. On the other hand, the well maintained unit (Curve 2) achieved its expected life of 14 years, while maintaining a high level of efficiency. BOMA goes on to say that because the "system" associated with Curve 2 was well maintained, at year 14, the failed compressor can be replaced, leading to an extension of the overall system by another 7 years.

On a final note, it has been shown (Air Conditioning, Heating, Refrigeration News 1986) that even during degradation, these systems still provide some nominal level of comfort. Unfortunately, this means that, while the system is operating inefficiently and preparing for a premature failure, the owners/users of this equipment are generally not aware of the degradation and the impending ultimate failure.

2.2 Federal O&M Energy Savings Potential

Most studies of commercial buildings estimate an O&M-related energy saving potential of between 5% and 30%. These studies generally have focused on low-cost O&M activities (also referred to as commissioning) of existing buildings. Table 1 presents a summary of these studies and calculated savings.

TABLE 1. Summary of Commercial Building O&M-Related Energy Savings Studies

Estimated Savings, %	Date of Study	Information Source [1]	Notes
5 to 10	1986	Thompson, T. A. "Preventive Maintenance Saves Energy and Dollars," *Engineered Systems.*	Well-developed O&M program savings.
15.4	1992	Herzog, P., and L. LaVine, "Identification and Quantification of the Impact of Improper Operation…" ACEEE.	3-year study of seven office buildings to quantify improved operations potential.
15 to 30	1992	Piette, M. A. "Diagnostics for Building Commissioning and Operation." LBNL.	Savings through improved operations and maintenance.
23	1994	Liu, M., et al., "Identifying and Implementing Improved Operation and Maintenance Measures…" ACEEE.	35-building and 104-school summary of energy cost savings from improved O&M.
15 to 25	1994	Szydlowski, R. F., et al., "No Maintenance - No Energy Efficiency." PNNL.	Savings identified through O&M measure case studies.
5 to 15	1997	Gregerson, J. "Commissioning Existing Buildings." E-Source.	44-building study of whole-building energy savings.
12	1997	Portland Energy Conservation Inc.(PECI). "What Can Commissioning Do for Your Building."	175-building study of savings.
12 to 30	1998	Claridge, D., et al., "Implementation of Continuous Commissioning…" ACEEE.	Continuous commissioning savings range.

[1] Full reference found in Reference section

While the average savings from these studies is about 16% of facility energy use, a lack of data specific to the Federal sector has led to development of a more conservative estimate. Taking an approach where barriers to implementation are assumed, resistance

to change is prevalent, and access to all systems is not likely, a conservative estimate of the achievable Federal O&M savings potential of 10% was selected.

To calculate the total energy and cost savings potential, these savings were applied to the FY 1999 Federal Buildings and Facilities Energy Use data, as reported in the DOE/FEMP Annual Report to Congress (DOE 2001a). Before these savings were applied, however, the energy use associated with military family housing was subtracted because these structures are not typically the target of O&M activities, and a significant percentage of these buildings have, or will be, undergoing some form of privatization.

Table 2 presents the results of the savings potential estimate with an annual savings potential of 0.03 Quads (where 1 Quad equals 1×10^{15} Btu) and $301 million. [To calculate dollar savings, a melded energy rate of $10/million Btu was developed from the data in the 1999 FEMP Annual Report to Congress (DOE 2001a).] Along with the savings is an estimate of the cost of these savings. This value is calculated using the average cost of $\$0.17/ft^2$ for commissioning existing buildings (PECI 1997). Applying this cost across the targeted non-residential Federal square footage, an estimated cost of $408 million dollars was calculated and results in a simple payback of 1.4 years. While this savings potential does exist in an annual sense, it will be necessary to allocate some portion of the savings for on-going activities if these savings are to persist.

TABLE 2 Federal Non-Residential-Building O&M Savings Potential

Category	**Value**	**Source Notes**
FY 1999 Federal building energy use	0.34 Quads	FEMP Annual Report to Congress
Estimated non-residential FY 1999 Federal building energy use	0.30 Quads	Total building use minus residential (military housing) use
Estimated energy savings percentage from improved O&M	10%	Conservative achievable Federal potential estimate
Estimated annual Federal energy savings from improved O&M	0.03 Quads	Calculated annual energy savings
Estimated annual Federal dollar savings from improved O&M	$301 million	Calculated annual cost savings
Estimated cost of improved O&M	$408 million	Cost based on average recommissioning cost of $\$0.17/ft^2$ (PECI 1997)
Simple payback	1.4 years	Calculated simple payback

2.3 Additional Impacts from O&M

Non-Energy Savings. Both downtime and overtime costs affect any organization's bottom line. Unfortunately, these costs are rarely linked to the true culprit – poor O&M. Proper O&M can result in reduced downtime and overtime, resulting in cost savings. Additional savings can accrue through increased health, safety, and productivity. Below are brief summaries of several studies/presentations dealing with O&M-related issues.

Several observations and findings made in an assessment conducted by the National Research Council (NRC) to review current Federal practices for planning, budgeting, and implementing facility maintenance programs are worth noting (NRC 1998):

- Federal buildings "must be well maintained to operate adequately and cost effectively, to protect their functionality and quality, and to provide a safe, healthy, productive environment for the American public, elected officials, Federal employees, and foreign visitors who use them every day."

- "The under-funding of facilities maintenance and repair programs is a persistent, long-standing problem."

- "Maintenance and repair expenditures generally have less visible or less measurable benefits than other operating programs. Facilities program managers have found it difficult to make compelling arguments to justify these expenditures to public officials, senior agency managers, and budgeting staff."

A 2000 report by the Government Accounting Office (GAO) ties together declining building conditions to declining O&M budgets/shortened equipment life and resulting capital investments (GAO 2000). A general finding of this report was that approximately $4 billion of repair and alteration work needs to be completed at GSA buildings. The repair and alteration needs varied across a range of areas and included major building components such as HVAC systems. A follow-up report was issued in 2001 that amplified the adverse consequences of delayed repair and alterations including health and safety concerns resulting from "dysfunctional air ventilation, inadequate fire safety systems, and unsafe water supply systems" and "higher operating costs associated with inefficient building heating and cooling systems." (GAO 2001)

Also to be considered are the potential impacts of inferior O&M on the indoor environmental quality (IEQ). Dr. William Fisk (LBNL) addressed this topic in a presentation to the Federal Facilities Council on November 27, 2001. IEQ is a relatively new area of study that looks into, among other things, the effects of factors such as lighting, thermal conditions, and air pollutants on the health, perceptions (comfort and safety) and productivity of building occupants. Note that these factors can and often are influenced directly by O&M practices such as temperature and humidity settings, filter selection and replacement, air ventilation rates, cleaning drip pans and ducts, and allowance for outside air.

2.4 Demonstrated Outcomes of Various O&M Approaches

A number of O&M approaches have already been successfully demonstrated. Results of some of these demonstrations are briefly summarized in the table below. More complete information for each of these approaches is presented in a case study format in Appendix B.

TABLE 3 Summary of O&M Approaches

Approach	**Results**	**Case Study in Appendix**
Continuous Commissioning	Average measured utility savings for 130 continuously commissioned buildings came in at about 20% with simple payback periods ranging from 0.3 to 2 years.	B.1
Steam Trap Maintenance Programs	A $120,000 steam system repair project reduced steam use an estimated 15% with a simple payback period of 0.3 years.	B.2
U.S. Postal Service Predictive Maintenance	Demonstration did not target or report energy savings. However, targeted breakdowns were reduced by 80%, mean time between failure significantly increased, and equipment maintenance costs per piece of mail reduced.	B.3
Decision Support for Operations and Maintenance (DSOM)	Prototype system improved central heating plant efficiency 17% (estimated simple payback period of 4.5 years) with additional cost savings and safety improvements realized. Subsequent system developments expanding DSOM applicability.	B.4

3.0 SUMMARY OF AGENCY FEEDBACK

As stated in Section 1.2.2, the FEMP O&M program must identify and respond to the O&M needs of Federal agencies if it is to be successful. It was decided that agency O&M needs would be identified as part of this study through meetings and interviews with agency O&M staff. After work began on this assessment, additional sources of information were identified: feedback from attendees at FEMP O&M workshops and findings from the 2001 FEMP customer survey. The key findings for each of these information sources is presented below.

3.1 Interviews with Agency O&M Staff

Contacts with agency O&M staff were established through the Federal Facilities Council Standing Committee on Operations and Maintenance. This committee is staffed by headquarters-level staff from many Federal agencies that manage O&M programs (e.g., budgeting and policy guidance). At the February 28, 2002, committee meeting, Mr. Ab Ream (DOE FEMP O&M Program Manager) briefly discussed FEMP's interest in developing an agency-responsive O&M program. Mr. Ream also distributed the questionnaire found in Appendix D and asked that the attendees make themselves and some of their site staff available to discuss their agencies' O&M needs. The questionnaire was also electronically transmitted to all committee members following the meeting. The questionnaire was intended to be more of a discussion outline than a strictly formatted interview. Agencies were asked to contact Mr. Dave Hunt (PNNL) to arrange a time to discuss the questionnaire. Agencies were also permitted to simply complete and return the questionnaire if they so chose.

Agency response to this request was very limited. Staff representing two agencies were interviewed while two other agencies returned completed questionnaires. While this level of response was somewhat disappointing, it is worth noting that these four responding agencies account for over 30% of the Federal building goal inventory. Also, agency feedback was received by the committee as a whole through the discussion at the February 28 meeting. Feedback was also obtained from one regional energy manager. Below is a summary of the findings from the agency feedback portion.

- Contracted (outsourced) O&M creates a number of issues and needs. This issue was raised at the February 28 meeting and again discussed at length in the agency interviews. Outsourcing at these agencies ranged from 50% (but expected to increase rapidly over the next few years) to 99%. The needs arising from outsourcing are
    - Ensure in-house contract administration staff have the technical skills to determine if O&M has been performed and, if so, if it has been done correctly.

- Provide incentives to contractors to do more work than minimum required under contracts.

- Develop O&M contract language that clearly, correctly, and thoroughly establishes proper O&M requirements.

- Funding needs exist across the board for training, staffing, and equipment. This is demonstrated in part by the amount of reactive maintenance now being performed in the Federal sector. Some specific needs related to the management of funds were also identified:

    - An accounting system that tracks and reports "in a meaningful way" actual costs for facilities repairs and O&M.

    - Ability to control and fully manage O&M funds. The issue here is that other programs are often permitted to borrow from O&M accounts to cover shortages. Repayment then often occurs late in the fiscal year when options to execute are often limited.

- Mode of O&M operation (reactive, preventive, predictive, and reliability centered) varies by agency

- Training is needed for specific energy intensive equipment, with emphasis on boiler operations

- Homeland defense may create requirements that compete with or are contrary to energy-efficiency goals. While this is not necessarily an O&M issue, it is possible that a) increasing attention to O&M may be a requirement for higher performing equipment such as air filters; b) there may be opportunities for overall efficiency gains through greater attention to operating practices; and c) implementation of new measures may present opportunities to optimize designs for energy efficiency (e.g., motor sizing, fan speed adjustments, and filter replacements).

- There was not a consensus on the role of FEMP in the Federal O&M arena; whatever help FEMP can provide in terms of technical guidance, innovative developments, and helping to create a message on the function and the resource requirements of O&M will be appreciated.

3.2 Feedback from FEMP O&M Management Workshops

An informal survey was administered at the end of the FEMP Operations and Maintenance Management workshops held in February 2001 (Honolulu, HI) and February 2002 (Portland, OR). Attendees at the 2001 workshop were asked the following question:

What are the two or three things that FEMP could do to help your O&M program?

Attendees at the 2002 workshop were asked two questions:

- What are your top two O&M headaches?
- How can FEMP help with your O&M program?

Although three distinctly different questions were asked in two different workshops, some trends emerged in the responses.

- More training was easily the most frequent response. The most frequently cited training need was for more money for agency staff to attend training. The need for more specialized equipment or topical (e.g., setting up a maintenance program) training was also frequently mentioned.
- There is a need for technical guidance on O&M issues. Specific guidance topics mentioned included designing direct digital control systems in new buildings, maintaining control systems, and primers on technologies and strategies.
- Many would like to have an effective message on the benefits of O&M to obtain management (resource) support.
- Several mentions were made of the lack of incentives to do a better job.

A listing of the responses for each of these questions is in Appendix E.

3.3 2001 FEMP Customer Survey

Results of the 2001 FEMP customer survey were released in February 2002. The study intended to collect information from FEMP customers on their use of and satisfaction with various FEMP services, determine an impact of FEMP services (project implementation and FEMP influence), and identify agency need for assistance with technologies and services. One key finding related to O&M appeared in this report – "Non-participants most needed services are whole-building design, and maintenance and operations services" (US DOE 2001b). The report went on to recommend that information regarding operations and maintenance be developed and made available to the Federal sector by FEMP.

3.4 Summary of Agency Feedback

Many specific needs were identified by the agencies through the various feedback mechanisms used in this analysis. The primary needs identified by the agencies appear to be:

- improved O&M contracting language and oversight

- increased resources to allow for improvement in site O&M delivery inclusive of increased and more specialized training

- more technical guidance.

Because feedback via surveys/interviews tends to focus on the present, the FEMP O&M program should plan to allow for a periodic or continuous agency feedback process. This will allow new issues such as homeland defense to be addressed once the agency interest is identified.

4.0 POTENTIAL FEMP O&M PROGRAM ACTIVITIES

The feedback received from the interviews with agencies' O&M staff, as discussed in Section 3, provides valuable insight into the types of O&M services and support the agencies have an immediate interest in. In addition, the FEMP O&M program staff have identified the types of services and support they see as needed for any organization to improve its O&M program performance in both the short- and long-terms. The O&M program cornerstone strategies identified by the FEMP team include the following:

- Develop improved metering and data analysis capabilities to allow for real-time decision-making. This is a somewhat broad category and includes concepts such as improved real-time energy use metering (you can't manage what you don't measure), implementation of commissioning programs (e.g., new system commissioning, recommissioning/retrocommissioning, and continuous commissioning), and automated diagnostics.

- Develop guidance and tools implementing new O&M strategies such as reliability centered maintenance programs, as well as guidance on new or advanced maintenance technologies such as infrared thermography and vibration analysis.

- Identify possible incentives for government and contracted O&M staff to better maintain and more efficiently operate energy intensive equipment/systems.

The agency-identified needs (contracting improvements, increasing site resources, and outreach/technical guidance) and the FEMP O&M-program-identified cornerstones are seen as quite complementary, as the potential program activities will demonstrate. The summary of these potential activities appears in Table 4.

Appendix C provides a short summary of FY02 FEMP O&M initiatives. It is anticipated that many of these activities, especially those focusing on training and outreach, will continue in FY03 and beyond.

TABLE 4. Summary of Potential O&M Program Activities

Recommended Activity	**Brief Description**	**Benefits**
O&M Contract Incentives	Work with agencies to develop and demonstrate benefits of O&M contract performance incentives language.	Addresses primary agency need (see Section 3). Can be quickly incorporated into existing O&M contracts.
Develop Model O&M Contract Specification for Energy Intensive Equipment	Work with agencies to develop comprehensive contract language for outsourced O&M actions to be completed on energy intensive equipment.	Addresses primary agency need (see Section 3). New language can be applied immediately to improve new O&M contract requirements.
Commissioning Guidance and Contracting Assistance	Develop commissioning materials such as model specifications and identify funding and delivery sources.	Addresses primary agency needs (see Section 3). Equips agencies to begin commissioning activities that have been demonstrated to improve energy efficiency in a cost effective manner.
Expand O&M Best Practices Guide	Update/incorporate new material (e.g., advances in control systems, testing equipment, and contracting language) into the FEMP O&M Best Practices Guide.	Addresses primary agency needs (see Section 3). Guide is a reference document for Federal facility and O&M managers.
O&M Site Audit Vehicle	Review protocols of existing audit vehicles for adequacy regarding O&M issues/concerns and identify and/or develop preferred protocol.	Addresses primary agency needs (see Section 3). Provides Federal sites with the vehicle(s) needed to assess low- and no-cost O&M opportunities.
Real-time Metering	Provide technical assistance to agencies developing metering strategies.	Addresses primary agency needs (see Section 3). Assists sites in identifying and planning metering strategies that will help improve overall operations.
FEMP O&M Program Outreach	Conference participation, technical paper publishing and presentation, and leading O&M working group under the Interagency Energy Management Task Force.	Increases visibility of FEMP O&M program. Raises awareness of potential benefits resulting from improved O&M.

Table 4. Cont'd

Recommended Activity	**Brief Description**	**Benefits**
Stakeholder Relationships	Maintain and/or develop relationships with the Federal Facilities Council Standing Committee on Operations and Maintenance and professional/ trade associations such as BOMA and IFMA.	Stakeholders can provide added technical expertise, visibility, and support.
Demonstrate and Promote Automated Diagnostics in Federal Facilities	Demonstrate the potential operations benefits of automated diagnostic technologies such at the Whole Building Diagnostician: Inform agencies of automated diagnostics technology developments.	Begins conditioning the Federal facility sector for next generation building operations control technologies.
Incorporate O&M into New Buildings	Develop guidance for O&M planning and resource allocation in new buildings during design phase.	Assists in identifying O&M resource requirements for planning and budgeting and is a starting point for commissioning of equipment.
O&M Organizational Audits	Perform audits that assess the organizational needs of site O&M programs.	Identifies improvements required in the site O&M organizational infrastructure.
O&M Contract Management Guidance and Training	Develop guidance for O&M contract managers/administrators that will assist them in verifying O&M contract requirements are correctly completed.	Addresses primary agency needs (see Section 3). Addresses agency-identified needs. Guidance will help ensure improved contract language provisions are satisfied.
BUILDER Energy Module	Work with the U.S. Army Civil Engineering Research Laboratory to develop an energy-efficiency module for inclusion in BUILDER – an infrastructure asset management system currently under development.	O&M for energy efficiency becomes institutionalized via widely applied asset management software.

5.0 KEY FINDINGS AND RECOMMENDATIONS

This assessment has incorporated the input and findings of a variety of sources including interviews with agency O&M staff, literature reviews on O&M practices, and previously completed studies on the effectiveness of Federal building operations programs and the implications of various O&M strategies. The resulting key findings are as follows:

KEY FINDING 1: *There is a significant opportunity for O&M improvements in the Federal sector and FEMP can and should play a key role in capturing this opportunity.* The literature searches and documented experiences of the FEMP ALERT teams clearly demonstrate the energy and cost savings potential available through improved O&M (low cost/no cost) of building energy using systems. While the savings estimates from these sources vary from 5% to 30%, the authors (conservatively) feel that 10% energy savings is achievable in the Federal sector through improved O&M practices.

KEY FINDING 2: *The majority of the O&M services in Federal buildings are provided via outsourcing. Further, Federal agencies are very interested in finding ways to more effectively manage these contracts.* It is believed that well over 50% of the Federal space is maintained by an outsourced O&M contract. Further, the outsourced square footage is expected to grow in the coming years as a result of the Federal Activities Inventory Reform Act of 1998 (Public Law 105-270) and renewed interest, particularly by the Department of Defense, in the A-76[1] process. Agencies readily identified contracted O&M services as a key area concern and, thus, opportunity. The specific concerns given were:

- Current contract language is dated and does not accurately or completely list O&M requirements.

- O&M contractors lack incentives to operate building energy using systems efficiently under the current contract.

- Agency staffs overseeing O&M contract performance seem to lack either the technical expertise to verify work is being completed, or the time resources to verify work is being correctly completed.

KEY FINDING 3: *Advances in O&M technologies, approaches, and strategies do not appear to have penetrated the Federal buildings O&M sector.* Cited studies and field observations have documented that most Federal sites administer maintenance on a breakdown and/or preventive basis. Examples of predictive and/or reliability centered maintenance programs at Federal sites are rare. Likewise, many people interviewed felt

[1] Circular A-76 established the Federal policy for the performance of Commercial Activities (CA) and procedures (including O&M activities) for studying and eventual private transfer. Additional orders have been issued to ensure that the CA requirements are offered to and provided by private industry except if a statue or national security requires Government performance or if the cost is unreasonable.

new Federal buildings are generally not adequately commissioned and that there are significant opportunities available through recommissioning/retrocommissioning. Finally, "new" technologies or techniques such as predictive maintenance technologies are typically under-employed in the Federal sector.

KEY FINDING 4: *Metering has been and will continue to be an area of need in the Federal building and energy sectors.* You can't manage what you don't measure applies to O&M as much as it does to other programs. Of late, there has been some renewed interest in this area as a result of the metering requirements for Federal sites contained in the proposed Senate version of the comprehensive energy legislation.[2] Regardless of the driver, increased metering capabilities will greatly assist Federal sites in more effectively monitoring their equipment status, operational effectiveness, and building energy performance.

With these findings in mind, the following recommendations are made.

RECOMMENDATION 1: *In FY03, FEMP needs to fund and begin activities aimed at key areas of needs and opportunities as identified in this report.* Recommended specific activities are as follows:

a. Address the issue of outsourcing of Federal O&M activities

   - Develop improved O&M outsourcing contract language that clearly calls out O&M activities to be performed by the contractor.

   - Identify and implement performance incentives in outsourced O&M contracts.

   - Equip the Federal O&M contract managers with the tools, skills, and resources they need to effectively oversee (verify) contractor performance.

b. Provide technical assistance to agencies and develop pilot programs aimed at applying new O&M-based technologies and strategies such as commissioning activities, establishing reliability centered maintenance programs, wider-spread use of predictive O&M technologies (e.g., infrared thermography), and demonstrations of automated diagnostics.

c. Provide technical assistance to agencies in the area of metering to include assisting sites in developing and implementing metering plans, identifying ways to finance site metering activities, and identifying new metering technologies.

d. Develop technical guidance on a range of issues that concern Federal O&M staff such as O&M contract management, building and equipment commissioning, building and equipment metering, and incorporating O&M requirements into new building planning and design.

[2] As of October 2002, H.R. 4 and S. 517 are in conference.

Note that there are many pilot and partnering opportunities for several of these areas because several agencies have already expressed an interest. Further, all pilots should include verification of results, analysis of effectiveness (including possible impact if applied across the Federal sector), recommendations for improvements, and outreach aimed at Federal O&M staff.

RECOMMENDATION 2: *Build FEMP O&M program visibility in FY03.* The primary benefit of program visibility is that it provides Federal O&M staff and O&M stakeholder groups a common point for information exchange. A number of separate O&M initiatives begun in FY02 and earlier (see Appendix C) have already established some visibility for FEMP in the area of O&M. The recommended activities listed below are aimed at increasing FEMP O&M program visibility:

a. Develop an updated and expanded O&M Best Practices Guide.

b. Increase the FEMP O&M training course offerings. Present the FEMP O&M course "Operations and Maintenance Management" more than once a year. Develop and deliver new O&M training courses that meet more specific agency needs such as O&M auditing, boiler maintenance and operation, and maintenance of building control systems.

c. Participate in nationally recognized conferences such as Energy 2003 and the World Energy Engineering Congress by presenting papers, chairing sessions, and managing program tracks.

d. Build relationships with customers and stakeholders;

   - Start-up an O&M working group under the Interagency Energy Management Task Force. This activity links FEMP O&M efforts with the agency energy program managers.

   - Continue to participate in the Federal Facilities Council's Standing Committee on Operations and Maintenance. This activity links FEMP O&M efforts with agency O&M program managers.

   - Identify other potential stakeholders such as the International Facility Management Association (IFMA) and BOMA International and build on these key relationships.

RECOMMENDATION 3: *Develop long-range FEMP O&M program plan*. Develop an O&M program plan targeting a 3- to 5-year implementation window. Develop specific goals, activities, and programs to positively affect the way O&M programs are designed, implemented and evaluated by FEMP's Federal customers.

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APPENDIX A

Glossary of Common Terms

APPENDIX A

Glossary of Common Terms

Availability: A measure of how often equipment will be accessible to perform the desired function or generate the desired product or outcome (i.e., cooling, heating, electricity).

Baseline: Data representing the initial state of equipment; typically referring to efficiency parameters, energy consumption values, or the general condition of equipment.

Benchmarking: The continuous process of measuring performance variables for use in comparison with previously measured data or comparison against similar measurements from other organizations/facilities.

Building Commissioning: A process of assuring that a building's systems function in accordance with design intent and the owner's/occupant's needs. Activities typically include verification and documentation that all building systems perform interactively in an efficient manner and that operations and maintenance actions are completed per original specification and manufacturer's recommendations.

Data Logger: Equipment used in the collection of information relevant to program study. Typical information collected for O&M studies includes run-time, temperature, pressure, power, or other operations statistics.

Indoor Air Quality (IAQ): Term used to refer to the overall characteristics of an interior environment, particularly as it applies to ventilation and pollutants.

Indoor Environmental Quality (IEQ): Refers to the factors that affect air quality, noise, lighting, comfort settings, and other ergonomic stressors, and their potential impact on the health, safety, and comfort of building occupants.

Maintenance: Activities related to the preservation of systems and equipment function.

Mission: The stated or understood objective of a site/building and the resources it houses.

Operations: Decisions and actions regarding the control of systems to meet the needs of the owners/occupants.

Operational Efficiency: The life-cycle cost-effective mix of preventive, predictive, and reliability-centered maintenance technologies, coupled with equipment calibration, tracking, and computerized maintenance management capabilities all targeting reliability, safety, occupant comfort, and system efficiency.

Operations and Maintenance: Decisions and actions regarding the control and upkeep of property and equipment inclusive but not limited to the following: actions focused on scheduling, procedures, and work/systems control and optimization; and performance of routine, preventive, predictive, scheduled and unscheduled actions aimed at preventing equipment failure or decline with the goal of increasing efficiency, reliability, and safety.

Persistence: The degree to which affected improvements continue to be realized over time.

Predictive Maintenance: Use of measurements that detect the onset of a degradation mechanism, thereby allowing causal stressors to be eliminated or controlled prior to any significant deterioration to the component's physical state.

Preventive Maintenance: Actions taken at regularly scheduled intervals with the goal of reduced downtime, prolonged system life, and acceptable levels of efficiency.

Reactive Maintenance: Activities targeting corrective actions necessary to repair a failed process or system.

Recommissioning/Retrocommissioning: Refer to the processes and action of commissioning, as applied to existing equipment and systems.

Reliability: A measure or indicator of how often equipment or systems will perform the desired function or generate the desired product or outcome.

Reliability Centered Maintenance: Actions taken based upon developed criteria where priority is given to the most critical components. Process emphasizes the use of predictive practices, however, includes aspects of reactive and preventive concepts.

Repair and Alteration (R&A): Generally refers to capital-intensive repairs required to keep equipment operational outside the scope of regular O&M.

APPENDIX B

O&M Case Studies

APPENDIX B

O&M Case Studies

B.1. CONTINUOUS COMMISSIONING

Description: Recommissioning/retrocommissioning -- the process of restoring the operation of building mechanical/electrical systems to their original design intent. Continuous commissioning is different from these two commissioning approaches in that it seeks to optimize HVAC system operation and control for existing building conditions [per reference below].

Benefits: Average annual savings for the 28 buildings tracked came to $\$0.64/ft^2/yr$, with the following averages for the various building uses: $\$1.26/ft^2/yr$ for seven medical research laboratory buildings, $\$0.43/ft^2/yr$ for six hospitals and five university teaching and office buildings, $\$0.22/ft^2/yr$ for seven office buildings, and $\$0.17/ft^2/yr$ for two school buildings. Average measured utility savings for 130 continuously commissioned buildings came in at about 20%. Note that benefits such as reduced equipment failures and increased occupant comfort were not addressed. Also note that the data presented did not include energy costs.

Cost: Reported costs were on the basis of labor costs of the initial commissioning effort only and not inclusive of metering costs, reporting costs, and cost of the time for the building staff. Annual labor costs per 1,000 square feet per year varied by building use from $226 (classrooms/offices) to $474 (hospitals).

Economics: Simple payback based on costs and benefits reported above ranged from 0.3 to 2.0 years.

Applications to date: Per the reference, operation of mechanical/electrical systems in over 100 buildings have been improved using continuous commissioning. Costs and savings were tracked for 28 buildings. Case studies of buildings recommissioned using other approaches can be located on the Internet, one such source being http://www.peci.org.

Potential applications and limitations: Any of the recommissioning approaches can be applied to a wide range of building types. Consider developing guidelines for best applications when accounting for building size, use, renovations, energy prices, etc.

Reference: Turner (Texas A&M Draft Guidelines for FEMP, to be available in FY03)

B.2. STEAM TRAP MAINTENANCE PROGRAMS

Description: Many Federal sites are using steam for heating or process loads. Steam trap failure rates on these systems typically approach 20%. Failed steam traps (those that are leaking or plugged) waste significant amounts of energy and cause numerous system problems. When a steam trap maintenance program is in place, steam traps are tested at regular planned intervals and repaired or replaced as appropriate. This reduces energy waste and helps ensure proper system operation. The values provided below are based on estimated and reported values from the case study in the reference document.

Benefits: Estimated 15% reduction in steam losses, resulting in annual savings of $350,000.

Applications to date: Steam trap maintenance programs have been around for decades. Testing methods and diagnostics have been improving over time.

Cost: A small steam system repair project was funded for $120,000 (in 1993). This system included 100 to 200 faulty steam traps and other steam system components requiring repair.

Economics: Simple payback period of 0.3 years.

Potential applications and limitations: All sites with steam distribution systems should have a steam trap maintenance program in place.

Other: Szydlowski (1994) details a more comprehensive steam trap O&M program that was not adopted by the site. The author goes on to note the need to receive buy-in from all levels of management in order for these programs to receive funding and yield predicted results.

Reference:

- Szydlowski, R.F. 1994. "No Maintenance – No Energy Efficiency." In *Proceedings of the 1994 World Energy Engineering Congress*. Association of Energy Engineers, Atlanta, GA.

- U.S. Department of Energy Federal Energy Management Program. 1999. Federal Technology Alert: Steam Trap Performance Assessment. DOE/EE-0193. Washington, D.C.

B.3. U.S. POSTAL SERVICE (USPS) PREDICTIVE MAINTENANCE

Description: With increasing automation, increasing mail volume, and a need to reduce operations costs, the maintenance staff at the USPS Columbus, Ohio determined that a predictive maintenance regimen for various automated mail handling equipment was needed. The maintenance staff developed a predictive maintenance program that makes use of infrared thermography, ultrasonic detection, and other technologies. While this particular case study does not link improved O&M with energy efficiency, it does demonstrate additional benefits that can be realized through improved O&M.

Benefits: Reduced targeted breakdowns by 80%; significantly reduced maintenance cost per 1,000 pieces of processed mail; and increased mean time between failure to several times that of USPS average.

Cost: Not provided.

Economics: Reference did not directly address this. However, replication of the approach by other USPS sites implies belief that costs were warranted by benefits.

Applications to date: Predictive maintenance applications are fairly widespread. Practices vary based on equipment type.

Potential applications and limitations: This particular approach was replicated at many other USPS sites. Predictive maintenance approaches are applicable over a widerange of building mechanical/electrical systems.

Other: Thermography and ultrasound approaches can also be applied to predictive maintenance of energy intensive building mechanical/electrical systems.

Reference: Cunningham, T. R., II. 1998. "PdM: An Effective Low Tech/High Volume Approach in the U.S. Postal Service." Presented at 6th Annual Society of Maintenance & Reliability Professionals Conference in St. Louis, MO, October 4-7, 1998.

B.4. DECISION SUPPORT FOR OPERATIONS AND MAINTENANCE (DSOM)

Description: DSOM is a technologically advanced approach to optimizing systems operations that employs site-engineered, diagnostic software. Applications to date have focused on centralized heating systems, but new applications are being developed. DSOM is reported to improve process efficiency (e.g., boiler efficiency), reduce maintenance costs, reduce energy consumption, and extend equipment life. This case study is limited to the first DSOM application, which was at the Central Heating Plant (CHP) at the Marine Corps Air Ground Combat Station Twentynine Palms, California.

Benefits: Maintenance cost reductions estimated by plant manager to be $100,000 to $150,000 as a result of prevented and anticipated component failures; 17% thermal efficiency improvement ($280,000/year), 30% plant capacity increase as a result of efficiency improvements resulting in delayed capital construction in excess of $1 million; operator training time reduced from 2 years to 6 months; and plant and equipment reliability increased.

Cost: Installation and software development costs totaled approximately $2.4 million.

Economics: Estimated simple payback period of approximately 4.5 years.

Applications to date: More advanced DSOM systems are under development. The installation at Marine Corps Recruit Depot Parris Island (DSOM II), where annual O&M savings of more than 35% are predicted, will include the central energy plant, the wastewater treatment plant, a remote steam plant, and site-wide electrical demand control/management. DSOM is also being installed at a central boiler plant for a New York City Housing Authority complex (a Department of Housing and Urban Development (HUD) supported program). This system is expected to reduce O&M costs by 37%.

Potential applications and limitations: Thus far, DSOM has been applied to "large" Federal sites with centralized heating systems; however, the DSOM approach is applicable to other centralized utility systems, as well as load management. DSOM is a high initial cost item. Funding may be available through agency budgets or even via a deferred payment approach, offered to Federal agencies by the Bonneville Power Administrationm. The DSOM approach is available only through the Pacific Northwest National Laboratory, so DSOM is not available via energy savings performance contracts (ESPC) or utility energy services contract.

References:

- http://www.pnl.gov/dsom
- "Marine Corps Uses Decision Support System to Manage Utilities" FEMP *Focus*, November 2001

APPENDIX C

FY02 FEMP O&M Initiatives

FY02 FEMP O&M INITIATIVES

Table C1 summarizes FY02 activities within FEMP that address the performance of O&M for energy efficiency in the Federal sector.

TABLE C1 Summary of FEMP FY02 O&M Initiatives

Activity	**Description**	**Tasked Organization**	**Status**
O&M Best Practices Guide	Reference document developed to provide Federal O&M and energy managers information on O&M management, technologies, and cost-reduction approaches.	PNNL	Completed development. First release in calendar year 2002.
O&M Performance Incentives	Investigate the potential to include performance incentives for energy-efficiency measures as part of facilities operations contracts.	PNNL	Ongoing work with a Federal agency to identify potential incentive approaches and pilot demonstrations.
Continuous Commissioning Guidelines	Optimizing HVAC system operation and control for existing building conditions.	Texas A&M University	Completed development. First release in calendar year 2002.
Outreach – Conference Presentations and Panels	Deliver presentations and organize panels on O&M programs, issues, approaches, etc.	PNNL	Presentation at Association of Energy Engineers (AEE) GLOBALCON in Philadelphia in March 02. Presented paper at AEE World Energy Engineers Conference (WEEC) Atlanta in October 02. Organized and chaired FEMP O&M panel for AEE WEEC in Atlanta in October 02). Participated in Energy 2003 planning committee meetings and developed O&M track for Energy 2003 (Orlando in August 03)

TABLE C1. Cont'd

Activity	Description	Funding Source/Lead Organization	Status
Assessment of Load and Energy Reduction Techniques (ALERT)	Teams assist Federal sites to reduce energy demand at sites experiencing price volatility and electric supply shortages. Teams focus on identifying low- and no-cost measures.	NREL subcontractors, ORNL and PNNL	FY02 ALERT activities included protocol development, training, and site assessments.
Federal Facility Council (FFC) – O&M Standing Committee	Committee addresses technical, administrative, and policy issues associated with O&M and repair of Federal facilities. Committee meets quarterly with membership consisting of Federal personnel representing operations, maintenance, and repair policy offices.	FEMP staff	FEMP staff monitored committee activities and participated as appropriate.
FEMP O&M Training Courses	FEMP offers the 2 day classroom course "Operations and Maintenance Management." A 2 hour module of the same title is offered via telecourse. Course developed for and delivered to Federal personnel. Funded by the FEMP training program.	PNNL	Both classes offered once in FY02.
FEMP O&M Website	Develop an O&M website as part of the FEMP website. Initial discussions in FY02.	Technologists, Inc.	Not completed. Target FY03 for development and initial posting.
Recommission-ing at DOE Facilities	DOE sites developing and evaluating recommissioning benefits. Funded by the FEMP Departmental Energy Management Team.	Argonne National Lab and PNNL	Results from efforts at both sites are anticipated in calendar year 2002.
Building Operator Certification (BOC) for Federal Agencies	Informational meetings with the Northwest Energy Efficiency Council to discuss a BOC program aimed at Federal agency staff in the Puget Sound Area.	DOE Seattle Regional Office	Discussions to continue in FY03.

APPENDIX D

Questionnaire

SPECIFIC QUESTIONS TO ASK OF FEDERAL AGENCY/SITE STAFF ON O&M PROGRAMS

This is not a survey. Instead, this is a list of questions that might be asked during interviews between agency O&M staff and Department of Energy (DOE) representatives. The purpose of these interviews is to assist the DOE Federal Energy Management Program (FEMP) in identifying programs and services that will be used by agency staff to improve facility O&M performance, reduce energy use, and help both the agency and FEMP meet the energy reduction goals mandated in Executive Order 13123.

Areas of O&M of interest to FEMP are those that directly impact site energy use. Examples include the following:

- Repair and upkeep of boilers, chillers, HVAC distribution systems, compressed air systems, and cooling towers.

- Operating schedules and practices of energy intensive building systems such as HVAC and lighting systems, or temperature settings for buildings and hot water.

- Agency policy or guidance impacting performance of building energy-related O&M such as standard clauses in building O&M contracts or guidance on motor replacement and rewind.

Individuals interviewed will not be identified in summary documents, nor will statements made be specifically attributed.

If you are interested in providing input into this effort, or if you have ideas regarding how this process can be improved or enhanced, please contact Ab Ream (DOE FEMP) at (202) 586-7230 or ab.ream@ee.doe.gov

1. In what mode(s) does your maintenance program (for mechanical/electrical equipment and systems) currently operate?

   __ Reactive – run it till it breaks
   __ Preventive – regularly scheduled/planned actions aimed at sustaining useful life
   __ Predictive – monitor equipment via measurements for onset of degradation mechanism and act/respond accordingly
   __ Reliability centered – determine types of failure most likely to occur, focus on preventing most serious failures, and emphasize predictive maintenance practices

2. What are the greatest needs for your O&M program?

__ Training for O&M staff. What type of training? _____
__ Funding for: __ staff __ equipment __ training __ system modernization
__ Improved contracting language – more prescriptive/specific O&M requirements in contracts and/or performance incentives for contractors.
__ Updated operations practices/guidance – to reflect changing mission needs and/or work with new equipment and systems.
__ Improved building designs – with staffing to match O&M needs, staff training on new equipment/systems, and more easily maintained and operated equipment.
__ Guidance on equipment operations best practices.
__ Advocacy – help from other sources in developing business case for increased O&M budgets. What points need to be made in the business case?
_____

3. In what role(s) can FEMP best assist your agency's/site's O&M program? If more than one role is selected, please rank order starting with "1" as the highest priority role.

__ As *advocate* developing business case (for resources) and case studies.
__ As an *integrator* of information on O&M (practices, technologies, programs, and policies) from government and non-government sources, and making information available on as needed basis.
__ As an *innovator* identifying and developing new programs and technologies aimed specifically at the federal sector.
__ As a *trouble shooter* providing assistance to individual sites on a reimbursable basis.
__ As an *advisor* providing information on best practices, new technologies and techniques, potential funding sources, etc.
__ Other – please describe: _____

4. In terms of your site's facility's management structure, who/what office directly oversees the O&M program?

__ Headquarters facilities management office
__ Regional facilities management office
__ Site facilities manager/director
__ Public works director
__ Building manager
__ Other – please specify: _____
__ Don't know

5. In terms of your facility's management structure, who/what office directly oversees the energy program?

__ Headquarters-based energy program
__ Regionally-based energy program
__ Site O&M office
__ Site facilities office
__ Other – please specify: _____
__ Agency/site [circle one] doesn't have an energy management program
__ Don't know

6. Please respond to the applicable question:

__ For building/site level people, is your O&M contracted out? __ Yes __ No
__ For regional/headquarters level people, please estimate the percentage of the square footage in your building inventory that is contracted for O&M: ____

What is the typical O&M contract term in years? ___

7. If your agency/site contracts out O&M services, does it currently allow for awarding the contractor additional fees based on performance incentives (for energy efficiency)? ___ No ___ Yes - please describe:
_____
_____
If no, would you or your site be interested in exploring this option further as a way to improve operations, reduce energy costs, and realize energy savings?
___ Yes ___ No
If yes, what might the limitations be? _____
_____

8. In general, how frequently are your building mechanical/electrical systems commissioned/recommissioned? (check all that apply)

__ Commissioned upon completion of construction/installation
__ Recommissioned only after problems are perceived
__ Recommissioned at regularly scheduled intervals/annually
__ Continuously monitor mechanical/electrical building systems and adjust, calibrate, and repair as required

9. FEMP is in the process of developing a client (federal agency) focused O&M program. Can you give specific examples of the products and services you think this program should offer?

_____

_____

10. Does your agency/site have any current initiatives aimed at improving O&M capabilities or performance? ___ No ____ Yes - please describe: _____

_____

11. What message needs to be presented to gain greater support for O&M programs? Examples to consider: Improved mission support; increased occupant satisfaction; safer and healthier work environment; reduced operating costs; reduced capital funding requirements; and meeting energy goals. _____

_____

_____

_____

Optional questions - Outreach:

12. How would you, the federal agency/site, like to receive technical information such as guidebooks?

___ Download materials from website
___ Hard copy in mail
___ CD-Rom
___ Other - please describe: _____

13. In general, should FEMP O&M program products and services be targeted at agencies

__ from the top down - start at headquarters and flow downward to sites?
__ from the bottom up – identify staff at field level and have those staff work information up through organization?
__ through regional office – can go up to HQ or down to site level as appropriate?

Any specific ideas? _____

_____

14. What is the preferred method of notifying agency and site staff of new O&M programs, products, and services?

___ Newsletter
___ Electronic newsletter
___ Mailings
___ Notification of sites from centralized agency organization (i.e., headquarters, regional office, command)
___ Other – please describe: _____

15. How familiar are you with DOE FEMP?

__ Never heard of it
__ Have seen some of their products/literature
__ Receive and read *FEMP Focus*
__ Have visited the website looking for information on energy efficiency
__ Have met with FEMP staff to discuss specific issues
__ Have attended FEMP training courses

Interview information:

Interviewed by:

Interview date:

Interviewee (circle one): Headquarters/policy level

Site level

Interviewee title:

APPENDIX E

O&M Workshop Feedback

FEMP 2001 Honolulu, HI, O&M Workshop

Tabulated participant response to the question: What are the two or three things that FEMP could do to help your O&M program?

- Additional funding for training of our personnel
- Additional funding for test equipment
- Conduct seminar on O&M performance contracts, i.e., boilerplate specs and model contract
- Training specifically targeted to administrators and financial officers and other executives that illustrates the bigger picture besides energy
- HVAC – Training for most economical uses
- Help with paying for energy audits
- Help set up a preventive maintenance training program
- Training
- Publications FEMP could provide literature on:
    - How to Prepare for This Year's Blackout
    - How to Prepare for Today's Blackout
    - Top 10 Ways to Save 10% In a Hurry
    - Top 10 Energy Investments
    - How to Calculate Your Actual Outside Air Needs
    - Training on Correct EMS Settings
    - Training for Management and Techs
- Funding estimates for facilities should include not only construction cost but also O&M costs over the entire life of facility
- Mandatory courses for management on the benefits of preventive maintenance and energy management to accompany "Executive Orders"
- Technical primers on different technologies along with applications, pros and cons
- Training courses like this one, which give a large perspective on the challenge of O&M – would like one on electrical topics vs. mech. topics like today.
- More training like this O&M workshop.

- Training programs in predictive/reliability maintenance

- Software programs – computerized maintenance systems

- Push to standardize energy management and control systems (EMCS) direct digital control (DDC) systems. Proprietary equipment and software make it difficult to operate and maintain.

- Preventive maintenance on structural programs, for facilities wooden, concrete, hollow, tile, etc. Work – carpentry, painting, masonry, drywall, etc.

- I want more training:
    - Preventive maintenance pertinent to building and housing maintenance
    - Trades involved:
        - Carpentry
        - Plumbing
        - Electrical
        - Painting
        - Air conditioning.

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Participant response to question: How can FEMP help with your O&M program?

- Make available O&M studies supporting Public Works staff efforts to "sell" to management, as a way to implement energy savings actions
- Help with commissioning-recommissioning
- I'm not sure but I will go to your website and consider this question more.
- Headaches in re-building verses replacement usually easier to get bigger money for replacement.
- Individual recognition for O&M workers
- Understanding HVAC by management
- With the Federal construction contracts, they don't know how to speak to putting in a DDC system and there is no one on site that knows what questions to ask to be sure they get proper training.
- On site evaluation of properties by an organization outside of the General Services Administration (GSA) would be valuable. If FEMP could do this, I believe GSA would be more receptive to specific training on building evaluation without being side tracked by anything else.
- Training for testing devices and equipment
- Maintenance optimization training
- Training workshop on testing equipment
- Facility management workshops.

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Participant response to question: What are your top 2 O&M headaches?

- Funding for energy compliance issues
- Staff training – how to justify to management – who often don't understand the need – and even more often don't care except as it affects bottom line
- The need for more training
- Time to do the job expected of me
- GSA is no longer hiring O&M staff and moving to contracting out. The transition is a morale downer due to staff accusation that the contractors are taking their jobs away from them
- Cost vs. comfort vs. customer feedback
- Lack of funding for projects
- Lack of management support for training
- Training
- Energy efficiency
- Lack of training
- Lack of staff
- The need for O&M plans at all sites
- Funding areas where there is no economic justification for savings, payback, etc. that you can show to management
- Short falls in funding for maintenance
- Changes in labor force – contracting out
- Limited and undereducated personnel
- Training
- Perception of O&M and lack of command emphasis

- Chain of command making important O&M decisions without the technical expertise
- Staffing for preventative and predictive maintenance
- Programs started and not finished because of budget
- Incentives to do better job
- Funding for equipment upgrades
- Lack of training
- Lack of ownership on the staff side
- Management structure
- Resources – money and people – not enough of either
- Old work force
- Training on new equipment
- Commissioning – not getting done
- Antiquated Johnson Controls Inc (JCI) 8540 must be replaced. JCI estimated $1.5M – no budget for this
    - What to replace with?
    - How to exit from JCI support contract?
- Funding for O&M target goals to meet objective – restrict actual work required
- Contractors have no incentive except to minimize effort to maximize profit.